State of California
The Resources Agency
Department of Water Resources
DIVISION OF ENGINEERING

THROUGH DELTA FACILITY PREFEASIBILITY STUDY

DRAFT MEMORANDUM REPORT
March 2007

Table of Contents

Through Delta Facility
Pre-Feasibility Study Memorandum Report

1. Introduction

1.1. Objective

At the request of Bay Delta Office (BDO) the Division of Engineering (DOE) conducted a pre-feasibility study of the Through Delta Facility (TDF). The TDF project envisions diverting 4,000 cubic feet per second (cfs) of water from the Sacramento River near Hood and releasing it at the South Fork of Mokelumne River near Beaver Slough. The project is part of the CALFED ROD-2000 water quality improvement alternative. Some of the issues that this pre-feasibility study will be addressing include, identification of diversion location, selection of canal alignment, preparation of inventories of the facilities required (intake and outlet structures, fish screens, bridges, siphons, outlet structures, gates, and flow control structures), and preliminary cost estimate.

1.2. Project Location

The intake of the TDF will be located at the Sacramento River near Hood and the outlet will be at South Fork of Mokelumne River near its confluence with Beaver Slough. Thus, the area impacted by the project includes areas along the TDF alignment between intake and outlet (See, Figure 1).

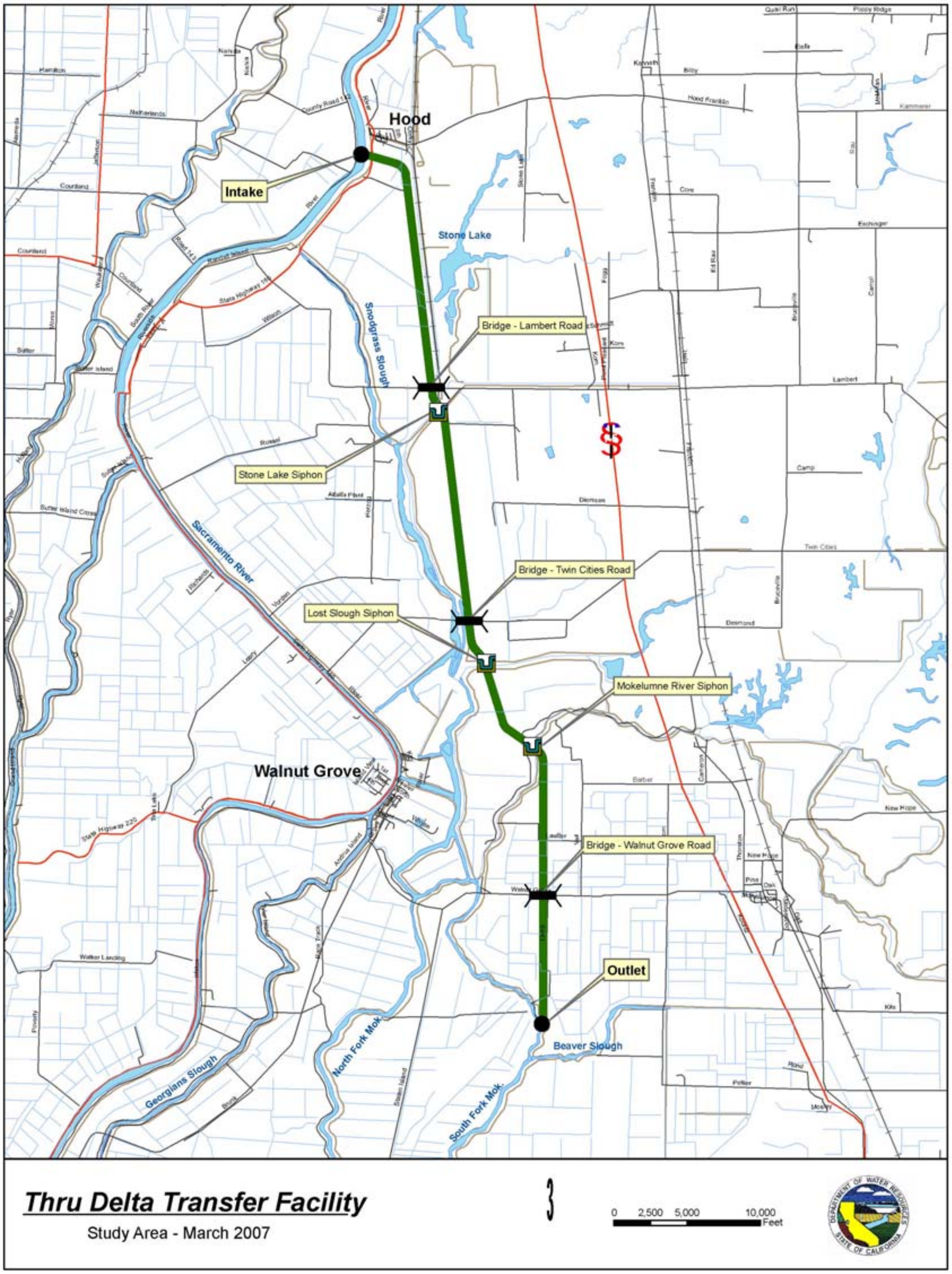


Figure 1: TDF Project Location

2. Hydrology and Geology

2.1 River Stage

Plots of the stage data for a typical year near the intake and outlet location are shown in Figure 2. The data shows that both intake and outlet sites are in tidally influenced areas.

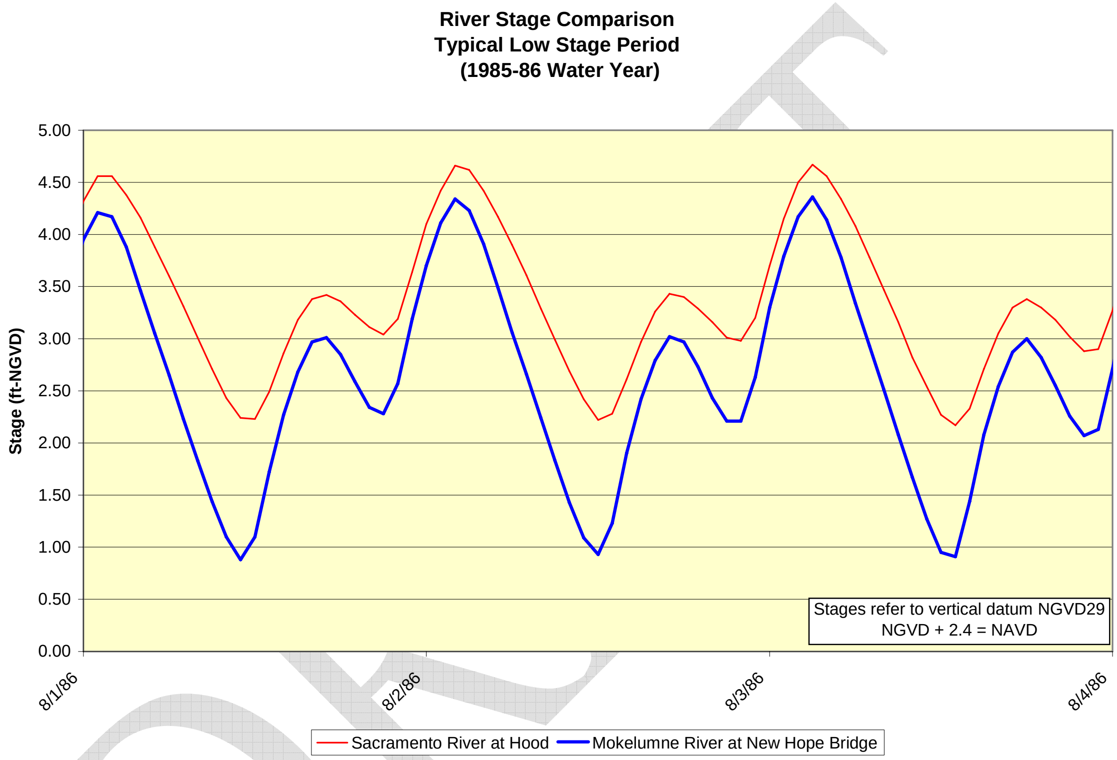


Figure 2: Stages at Sacramento River near Hood and Mokelumne River

Summary of the stage statistics near the intake and outlet sites are shown in Table 1. The minimum water level in Sacramento River near Hood reached to about 1.5 feet. The 100-year storm elevation is about 24 feet. On the outlet location, the minimum water elevation reaches to about 0.5 feet. The 100 year return flood elevation at the outlet is about 9.1 feet.

The TDF canal will be operated during low flow periods only. Thus, the operating range of WSE at the intake facility was taken between1 foot to 6 feet. The upper limit of elevation was set such that it covers approximately 80% of the Sacramento River stages. The operating range of outlet facility will vary between 0.5 feet to 2 feet. During high flood conditions the flood gates located at the upstream and downstream of the canal will be used to block the flood flows from coming into the canal. There will be one foot of margins between the maximum operating elevation and elevation of the top of the gates. The top of the upstream and downstream gate will extend up to 7 feet and 3 feet, respectively.

Table 1: Water Surface Elevation for Sacramento River and Mokelumne River

Location No	Location Description	Minimum Stage (ft)	100-Year Flood Stage (ft)
1	Sacramento River at Hood	1.41	24
2	South Fork Mokelumne River near Beaver Slough	0.52	12.7
3	South Fork Mokelumne River near Now Hope Landing	-	18.8
4	McCormick-Williams Tract	-	14
4	Lambert Road U/S of Stone Lake Drainage	-	13.3

Source: Beach Stone Lakes and Point Pleasant Flood Protection Study—Evaluation of Consumnes River Dry Dam Alternative, YOST Associates, July 2006.

2.2 Groundwater

Typical ground water data from the three observation wells along the TDF canal alignment are shown in Table 2. These were the three stations located closest to the proposed TDF alignment. The groundwater elevation along the alignment is shallow with a mean elevation of about -3 to -5 feet. One of the stations, located in the middle of an agricultural field, has deep groundwater elevation. It could be attributed to overdraft for irrigation purposes.

Table 2: Annual Groundwater Data along the TDF Alignment

Station	GW Surface Elevation (feet)		
	Mean	Minimum	Maximum
05N05E19D001M	-5.75714	-9	-3.8
05N05E31A003M	-3.13333	-6.2	1.1
05N05E06B001M	-20.072	-29.7	-13.3

2.3 Suspended Sediments

Sediment data from the Sacramento River near Freeport is shown in Figure 3. The transported sediment load varies with the total Sacramento River discharge and there is a wide variation in the sediment load. The vertical distribution of the sediment data was not available. Generally, the sediment concentration is higher at the canal bottom than at the top of canal. Thus leaving adequate margin between intake sill and the canal bed will help to exclude most of the sediments from entering the TDF canal.

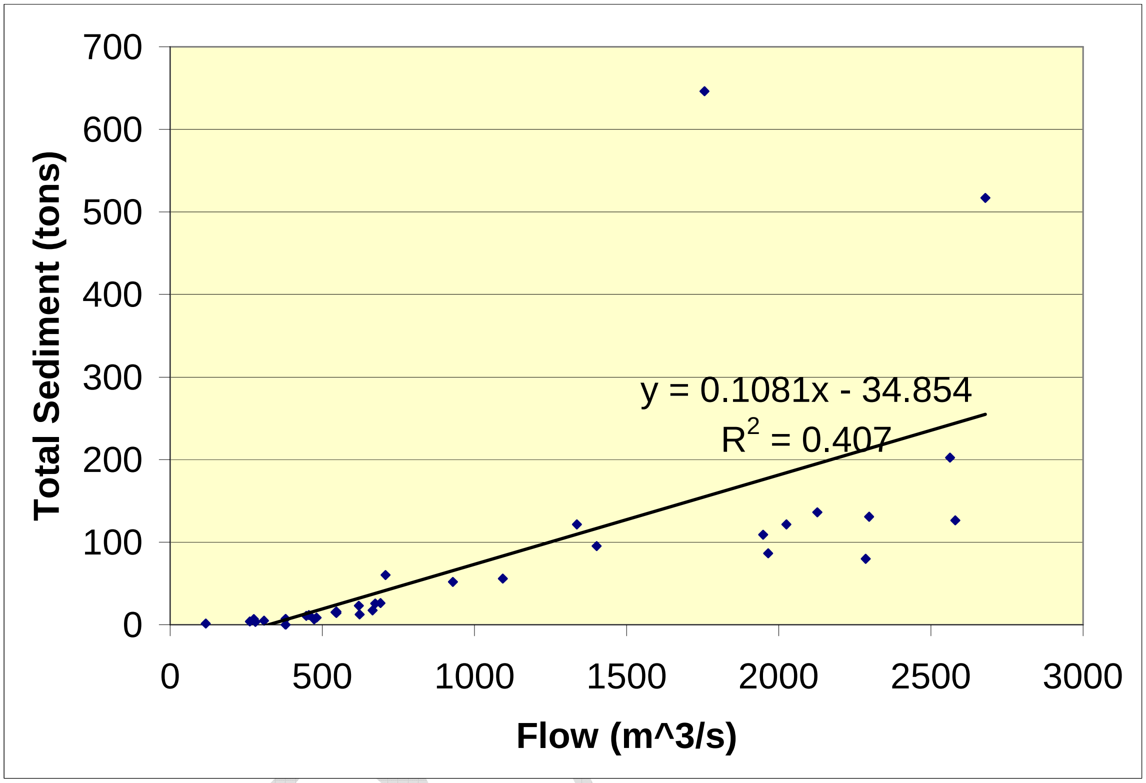


Figure 3: Variation of Total Sediment Load at Sacramento River near Freeport

2.4 Cross Drainage

The proposed TDF canal intersects three major drainages; the Stone Lake Drainage, Lost Slough, and Mokelumne River. The Stone Lake Drainage drains the Morrison Creek basin, which includes some highly urbanized watersheds. Lost Slough and Mokelumne River drain the Mokelumne River basin. In order not to disturb the existing waterways, siphons will be provided under major rivers and slough crossings.

The TDF alignment will interfere with the runoff from the local drainage basins and block flows from Delta islands and drainage sloughs. The flows from islands and local drainage basins are primarily sheet flows. Currently, these flows are directly discharged into the surrounding Delta sloughs. Once the TDF alignment is in place, the flow path of the local drainage will be altered.

The capacity of Mokelumne River near McCormick-Williams Tract is not sufficient to handle the historically large floods such as flood of 1997, a 100-year return period flood. The high flood in Mokelumne River causes distresses and occasional failures of the levees surrounding the McCormick-Williams Tract. If the McCormick-Williams Tract gets flooded, it causes additional problems to the TDF embankment. To avoid the failure of island levee, the flood carrying capacity of the Mokelumne River need to be increased. This could be achieved either by dredging of channel or by providing setback levees or the combination of two. The flooding risk of the McCormick-Williams Tract could also be reduced by strengthening and raising the elevations of existing island levees.

2.5 Foundation Condition

The geological information along the canal alignment was taken from Peripheral Canal study report (DWR, 1973) and Delta Atlas. Based on the Peripheral Canal Geology and Soil Testing results, approximately 80% of the materials down to a depth of 30 feet were cohesive soils consisting mostly of lean clays, fat clays, and sandy clays. The remaining 20% of material consists of silts and sands. Both reports indicate that the soil type along the alignment is almost free of organic materials.

3. TDF Components

3.1 Canal Alignment

The proposed TDF alignment starts from Sacramento River near Hood and ends at South Fork of Mokelumne River, near Beaver Slough (See, Figure 1). The TDF canal alignment was selected based on geological and foundation conditions for the construction of embankment, ease of alteration and relocation of existing facilities such as roads, and required location of the intake and outlet structures. Consideration was given to avoid communication towers, sharp bends, wetlands, and places of historical importance along the TDF alignment. The shortest canal was preferred considering the anticipated canal construction cost and land acquisition cost. The alignment was selected to pass through or close to the properties owned by DWR. This will allow the DWR properties to be used as borrow pits. However, the right of way issues were not addressed at this stage.

At the start, the TDF canal alignment follows parallel with the abandoned Southern Pacific Rail Road track. The existing railway track could be used as one side of the embankment fill, which will reduce the canal right-of-way. The existing railroad embankment might need upgrades to make it suitable to canal embankment. Savings from use of existing railroad embankment and reduced right-of-way costs likely would be upset by the need to upgrade the existing embankment. At about 3.5 miles downstream of the intake, the TDF crosses the railroad track and Stone Lake Drain and enters Glanville Tract and McCormick Williamson Tract. After crossing the Mokelumne River, the TDF enters New Hope Tract. The total length of the TDF canal is about 12 miles and the major components of the TDF are shown in Table 3.

Table 3: Major Components of the TDF

Intake Facility	Trash rack, fish screen, fish-bypass channel, low-head pumping plant, and flood control gates
Outlet Structure	Flood Gate, Fish Barrier, Riprap bed
Canal	Unlined canal (approximately 12 miles long)
Siphons	Stone Lake Drain, Lost Slough, and Mokelumne River
Bridges	Highway 160, Service Road, Lambert Road, Twin Cities Road, and Walnut Grove Thornton Road
Levee Strengthening	McCormick-Williams Tract Surrounding Island
Delta Slough Enlargement	Beaver Slough, South Fork Mokelumne River between Beaver Slough and Terminous Island

The TDF alignment deviates from the earlier studied Peripheral Canal alignment. The Peripheral Canal followed an easterly alignment to allow excess borrow from the excavation to be used for the construction of the I-5 freeway. Construction of

I-5 is already completed. Some of the borrow pits, excavated during the construction of I-5, are still on properties owned by the DWR. However, these borrow pits have since filled with water and would probably be designated wetlands habitat making them more difficult to use for the TDF canal.

3.2 Inlet/Outlet Sill Elevation

The Sacramento River near Hood and Mokelumne River near Beaver Slough river cross sections were taken from the DSM2 model input data. The minimum elevation of channel bed for Sacramento River near Hood and Mokelumne River near Beaver Slough are -21 feet -13 feet, respectively (See, Figure 4). The primary objectives in the determination of the intake sill elevation were to minimize the entry of sediment into the canal, and also to minimize the width of the intake facility. The intake invert should be placed at an elevation sufficiently high to confine the bed load to the river channel. On the contrary and to minimize the width of intake facility, the intake invert should be takes as closer to the river bed as possible.

The invert for the upstream intake at Hood was set to -12 feet elevation. This provides a clearance of about 9 feet between the average elevation of river bed and the intake sill elevation. Because of the nonlinear distribution of sediment load along the flow depth, most of the sediment load will be concentrated on the bottom of the channel cross section. Thus providing a margin of about 9 feet between the channel bed and intake sill will help to exclude most of the sediments from entering the TDF canal. The operational range of WSE at the TDF intake is 1.5 feet to 6 feet. The corresponding operating range of flow depth at the intake varies between 13.5 feet to 18 feet.

The sill elevation of the outlet was determined such that the channel could carry the design discharge during low flow condition and the excavation requirement is also minimized. To minimize the excavation, the outlet invert will be taken closer to the average channel bed elevation. The invert of the outlet canal will be set at -10 feet elevation. The operational range of WSE at the TDF outlet varies between 0.5 feet to 2 feet. Thus the operational depth of flow at the outlet is between 10.5 feet to 12 feet.

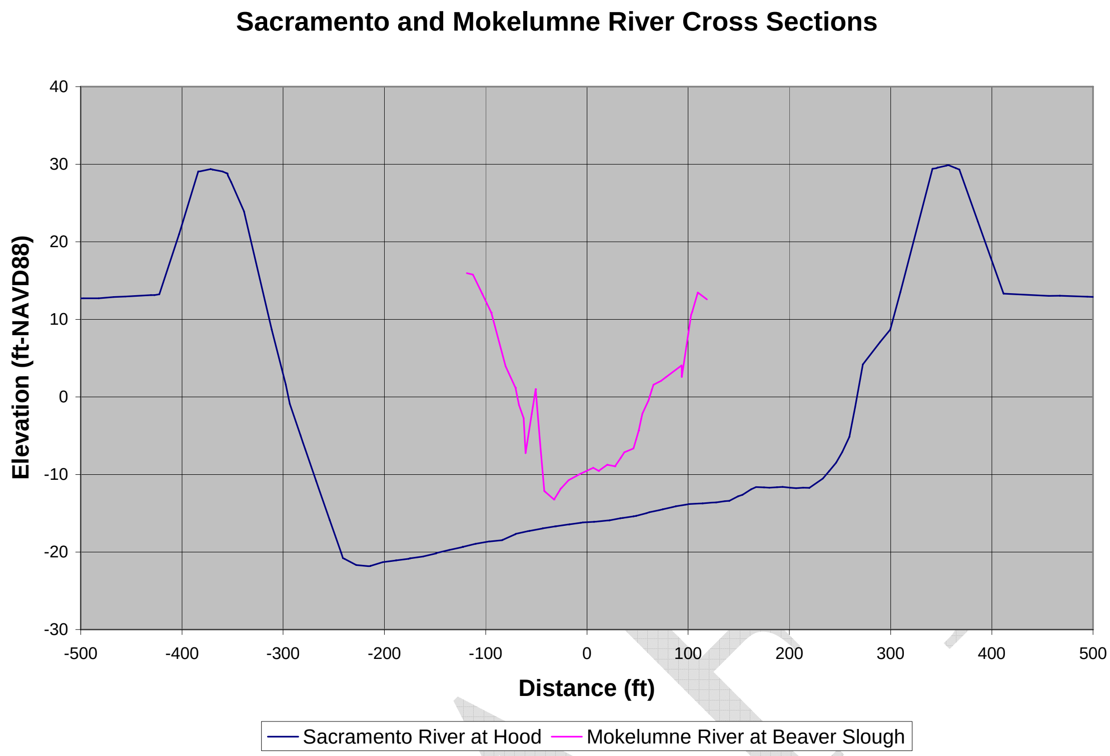


Figure 4: River Cross Section at Intake and Outlet

3.3 Canal Geometry

The TDF canal was designed to carry discharge of 4,000 cfs. The canal will be unlined and will have a trapezoidal section. To avoid the erosion of the embankment and canal bed maximum permissible velocity was limited to 2.5 ft/s. The inside and outside of the canal embankment will be sloped to 3H:1V and 2H:1V, respectively. This slope will be maintained from the canal bottom to the embankment top. The longitudinal slope of the canal was set to 1 foot per 10,000 feet (0.0001) and Manning's n was set to 0.018. Under these conditions, the required width of the canal at the base is about 90 feet. Since there are no turnout facilities along the TDF, this channel shape will be maintained throughout the TDF alignment except at bridges and siphons. At these locations a rectangular canal will be provided.

Throughout the alignment, the embankment top will be at least 4 feet above the maximum water surface elevation. This will provide freeboard against wind surges, embankment consolidation, subsidence, and erosion. The embankments on both sides of the canal will have 16-foot wide access roads with 3-foot shoulders. As a result the top width of each embankment will be 22 feet wide.

3.4 Embankment Top at Inlet/Outlet

At the intake and outlet locations the embankment top will be raised to existing levee elevation. This will help to prevent the flood flow going into the TDF canal or adjoining farm. This embankment configuration will extend from inlet/outlet channel location to respective flood gate. The Sacramento River near Hood is approximately 700 feet wide and the tops of the levees are at about 30 feet elevation. The Mokelumne River levee top elevation near Beaver Slough is about 16 feet (See, Figure 4). The top of the TDF canal levee will be at 30 feet elevation at the intake, and at the outlet it will be at 10 feet elevation. The new embankment section will be engineered to function adequately during extreme flood events. On the interior side the engineered embankments will have 3H:1V side slopes. On the outer side the embankments will have a 2H: 1V slope. Riprap slope protection will be placed on all embankments to avoid erosion from wind-wave action that could lead to embankment failure.

At other locations along the alignment, the top of the embankment will be at least 4 feet above the maximum water surface elevation. This will provide freeboard protection against wind surges, embankment consolidation, subsidence, and erosion. Where required, the height of the embankment will be increased to allow for additional subsidence and to provide sufficient freeboard for flood protection.   Particularly, the embankment height needs to be raised at slough crossings such that the flood water from slough is not coming into canal.

3.5 Intake Facility

The intake facility is located on the east side of the Sacramento River, avoiding areas of secondary currents. One of the objectives of the intake location was to minimize the entry of sediment into the canal. A general layout and profile of the plan is shown in Figure 5. The TDF canal alignment makes an angle of about 90^0 with the Sacramento River. The Highway 160 Bridge piers could be aligned in an angle to reduce the vortex formation on either side of intake facility and to provide uniform distribution of the velocity across the intake width.

The main features of the intake systems are; a floating trash deflector, major bridge for Highway 160, a service road, flood gates, trash rack, fish screen and bypass canal, and a pumping plant.

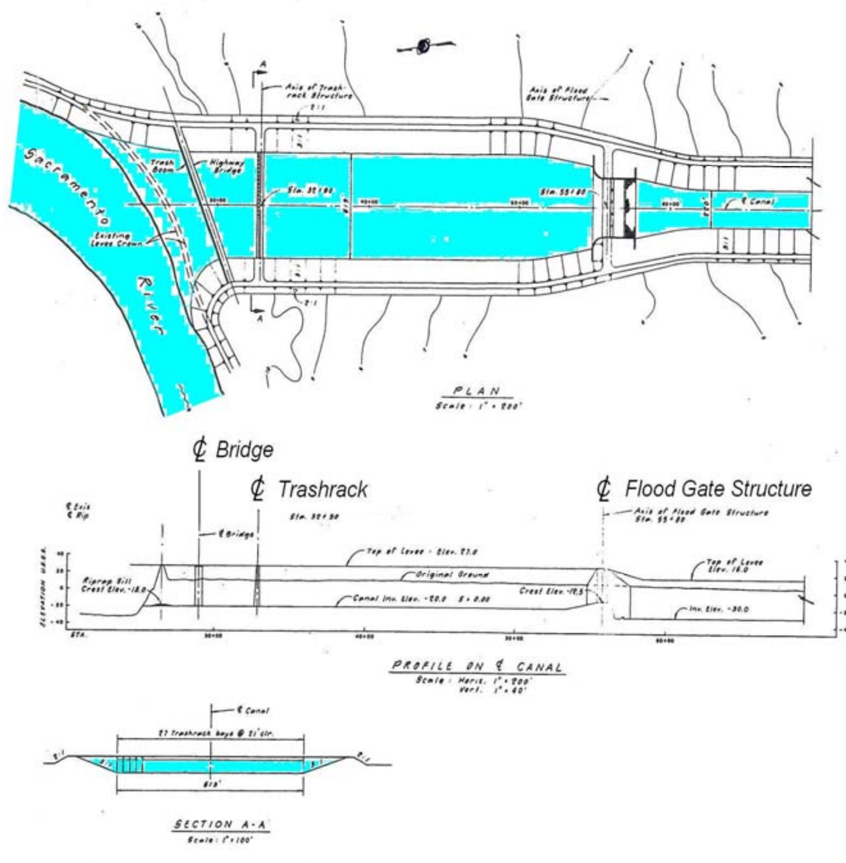


Figure 5: General Layout and Profile of Intake Systems

3.5.1 Trash Deflector and Highway 160 Bridge

Floating trash deflector will be used to stop the large debris coming into the Intake Facility. The floating deflectors will be supported by Dolphin piles upstream of Highway 160 Bridge. To stop the entry of logs and other underwater debris the deflector will be provided with the hanging chains. The chains will extend up to the river bed elevation. A bridge will be provided for the Highway 160 traffic. The crown of the bridge will at elevation 30 feet. The piers of the bridge will aligned such that uniformity of flow is maintained in the TDF channel.

3.5.2 Floodgates

Radial flood gates will be provided to isolate the intake facility from the Sacramento River during high flows. The flood gates could also be used to regulate the flow into the pump area. The gate structure will consist of 3 bays each having a clear spacing of 30 feet. The bays will be separated with a six foot wide pier. The gate will extend from intake sill (-12 feet) to 6 feet elevation. Concrete head wall will be provided from elevation 6 feet to elevation 30 feet. Along with the radial gates, a service bridge will be provided. The service bridge will provide support for motors and hoists. From the intake to the location of flood gates, the top of the embankment will extend to elevation 30 feet. After the gate, the embankment top will be lowered to 14 feet elevation level.

The radial gates will be of welded steel plate type. The gate will be supported by two arms and two pin bearings. There will be a reinforced concrete service bridge which will be used for servicing flood gate. The bridge will also provide area for gate hoisting equipment as well. The bridge crown will be provided at elevation 30 feet to provide enough clearance during high flood period.

On the downstream of the gate, a concrete basin will be provided to dissipate excess energy. To prevent scouring of the channel, riprap will be provided to downstream from the basin. The riprap will extend up to maximum operating elevation of 6 feet on both sides of the embankment. A typical flood gate structure layout is shown in Figure 6.

3.5.3 Trashrack with Cleaning System

A trashrack with cleaning system will be provided to protect the fish screens and pumps against the incoming debris. The trash rack panes should be made of anti-fouling steel with a maximum clear opening of about 6 inch. The cleaning of the trashrack will be carried out by automated trash rack cleaning system. The trashrack cleaning machine may be fixed type, serving only one clearance or of movable type cleaning multiple racks along the intake. The top of the trashrack system will be at 10 feet elevation. To reduce the operating costs, the operation of the cleaning machine may be automated.

3.5.4 Sediment Ponds

Sedimentation basin may not be provided for the TDF intake facility. It was expected that the sedimentation issue will be managed by the selection of intake sill and the permissible velocity in the canal. As explained earlier, the intake sill will be placed at -12 feet elevation whereas the average River bed elevation near intake site is -21 feet. Considering the nonlinear nature of the distribution of the sediment along the depth, this margin will minimize the entry of sediments into TDF canal. The permissible in the canal was set to 2.5 ft/s. This velocity was selected to prevent the scouring of the canal bed.

3.5.5 Fish Screen with Cleaning System

The fish screen facility is located immediately downstream of trash rack (See, Figure 4). The objective of the fish screen facility is to pass the design diversion flow, over a range of water levels, while protecting juvenile fish from entrainment, impingement, and migration delay.

The fish screen design criteria are designed to protect the Delta Smelts. The proposed screens will meet applicable design criteria set forth by the California Department of Fish and Game (DFG) and the National Marine and Fisheries Service (NMFS) (See, Appendix A). Some of the pertinent criteria used to size the fish screen facility are shown below.

Approach velocity (Va): 0.2 ft/s
Sweeping velocity (6Va): 2 ft/s
Angle of inclination: 5.7 degrees
Canal velocity in front of fish screen system: 2.2 ft/s
Maximum fish exposure time in front of screen: 60 sec
Maximum length of screen = 120 feet
Bar opening: 0.0689 inch

The proposed fish screens will be vertical profile bar type made of antifouling material. The screen will be equipped with automatic cleaning device to continuously clean and to prevent excessive debris buildup. To minimize the span of the fish screen facility, the screens will have V shaped configuration. The components of each fish screen facility will include a fish screen, cleaning device, adjustable baffles, debris collection and removal system, reinforced concrete box culvert structural section, and an access road.

For the given permissible approach velocity of 0.2 ft/s and deign discharge of 4,000 cfs, the minimum required screen area is about 20,000 ft^2. Assuming that the top of the screen will extend up to elevation 2 feet, the height of each screen is 14 feet. In order to satisfy the maximum exposure time of 2 seconds in front of screen, length of each screen need to smaller than 120 feet. To minimize the width of the fish screen facility, the screens will be configured in v-shape. In all there will be 7 bays (14 screens) and there will be bypass channel at the end of each bay. Bypass channel at the end of fish screen will be 2 feet wide and all pier width at the beginning is also 2 feet wide, the total length of the fish screen facility is 184 feet. A schematic of the fish screen layout is given in Figure 7.

The fish screen facility will be equipped with an automated cleaning device. Flow guide louvers will be provided on each screen to provide a uniform distribution of velocity across the screen length.

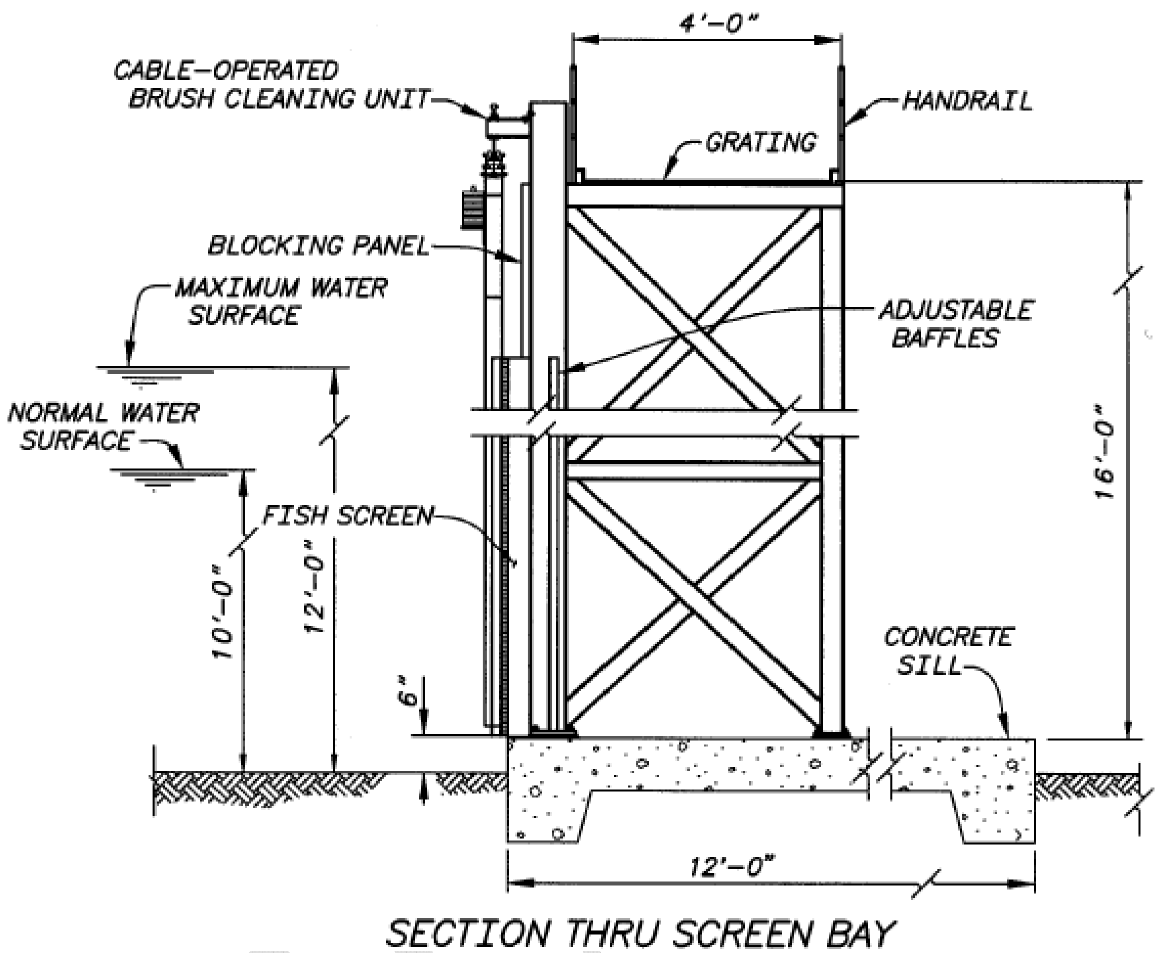
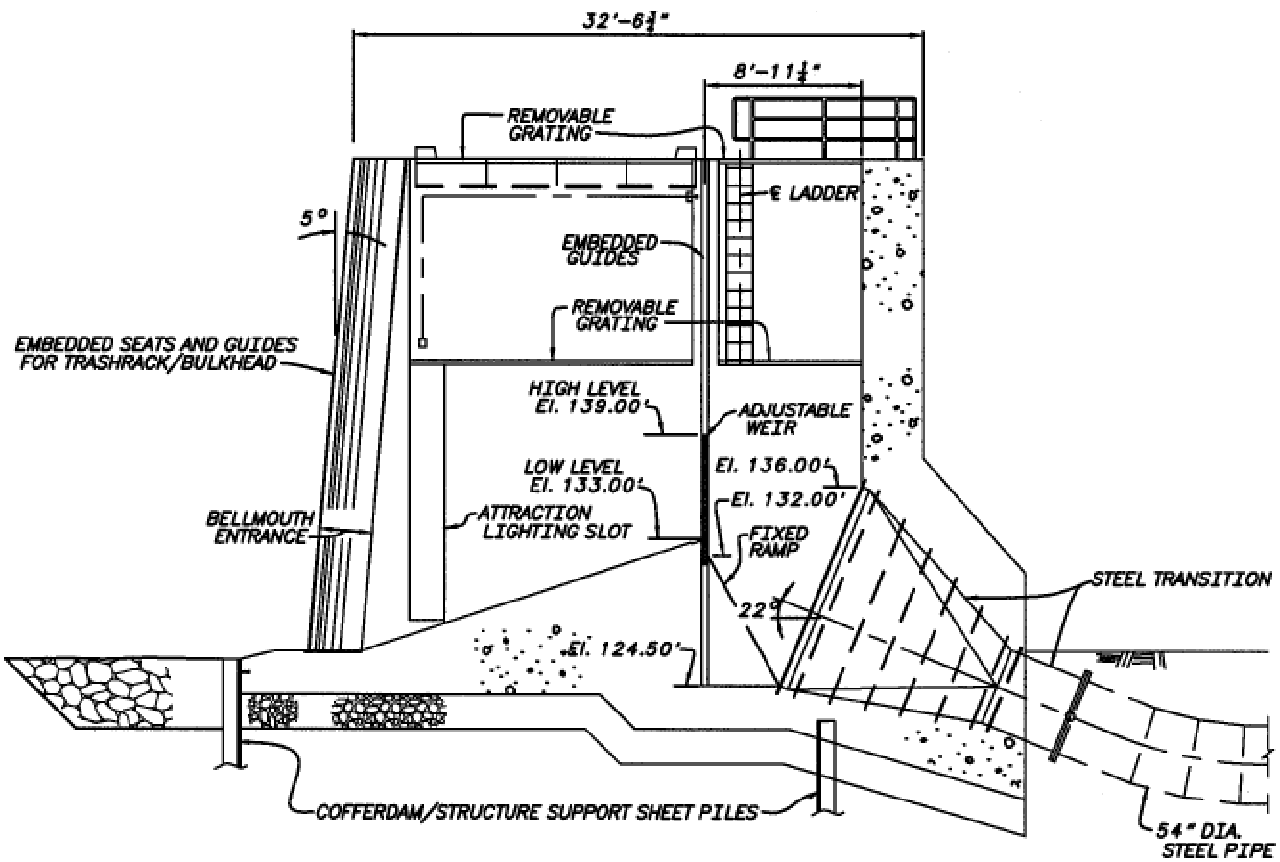


Figure 7: Plan and Section through Fish Screen Bay

3.5.6 Fish Bypass Channel

At the end of each fish screen, bypass will be provided to take the fish back to Sacramento River. The bypass channel will be 2 feet wide. The flushing velocity will be kept to about 5 ft/s so that the fish do not come back to the screen area. To maintain the desired velocity each bypass channel will have its own pumping unit. The pumps are also required because of the location of the project in a tidally influenced area. The capacity of each pump will be about 60 cfs. The outlet of the bypass channel will be taken to areas so that the migrating fish are not consumed by predator species. A typical schematic of bypass channel is shown in Figure 8.



SECTION THRU FISH BYPASS ENTRANCE

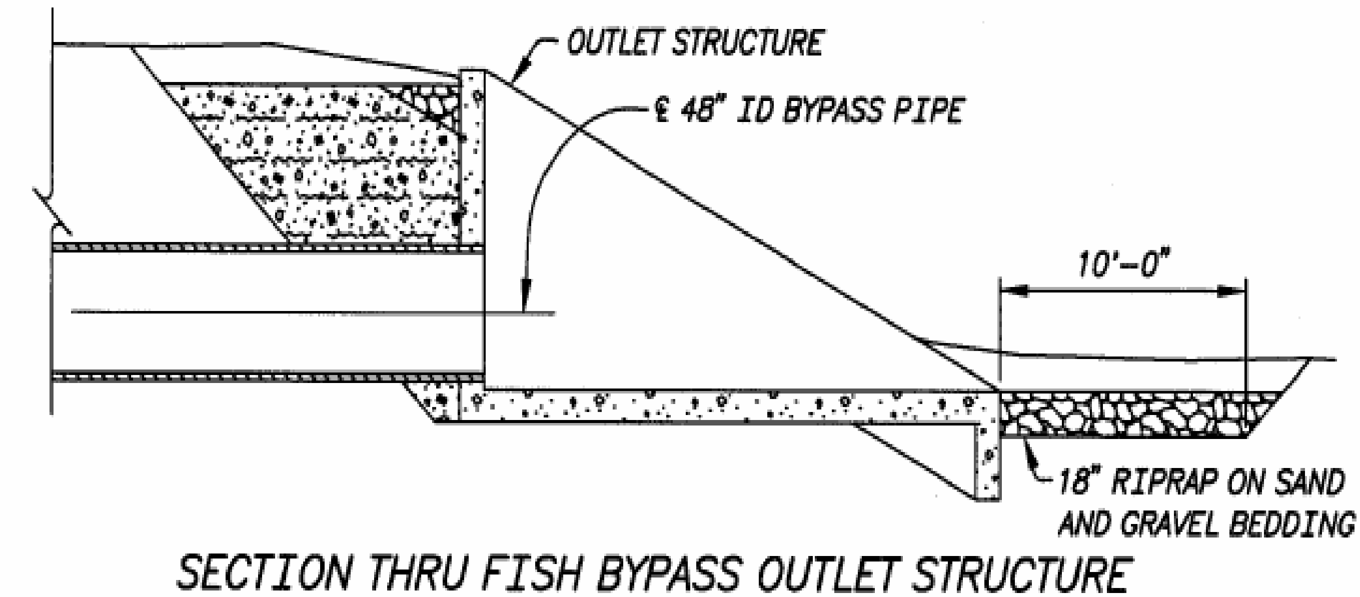


Figure 8: Section through Bypass Channel Inlet and Outlet

3.5.7 Fish Ladder

At this stage of design, there is no fish ladder in the intake site. A fish ladder could be provided to help the migrating fish to pass around the pump. It is expected that the TDF will not be operated during the Salmon migrating season, similar to that of Delta Cross channel. This will preclude the need of providing fish screens.

3.5.8 Pumping Plant

Both the intake and outlet facilities are located in tidally influenced areas. As a result, to deliver the design flow of 4,000 cfs flow over constantly changing head, pumps are required. Pumping plants are located on the downstream of fish screen (See, Figure9). The pumps were designed for an average delivery head of 8 feet, which falls in the low head range. The pumping plant consists of five pumping units, with a capacity of 833 cfs each, totaling a maximum pumping capacity of 4,165 cfs. In addition, one spare pump will be provided for emergency and regular maintenance purposes. This combination of pump size will allow flexibility in operations when needed. Axial pumps, which are suitable for low head and high discharge, will be suitable for these conditions. The pump delivery head keeps changing constantly, so the pumps should be selected such that its efficiency remains near constant for a wide range of delivery head.

The pumping plant is a reinforced concrete sub-structure, steel superstructure equipped with a gantry crane. A formed suction intake (FSI) will be mounted to each pump below the impeller to eliminate vortex formation in front of the pump. The size of the pumping units could be changed in the later stage considering operational flexibility and submergence requirement. Usually, smaller pumps have lower submergence requirements than the larger pumps. The pump type will be self-priming type with no vacuum system required. This will make easier for remote operation of the pumps. Stop gates will be provided in front of each pumping plant intake. This will allow individual pumping units to be shut down and serviced while the rest of the units continue operating.

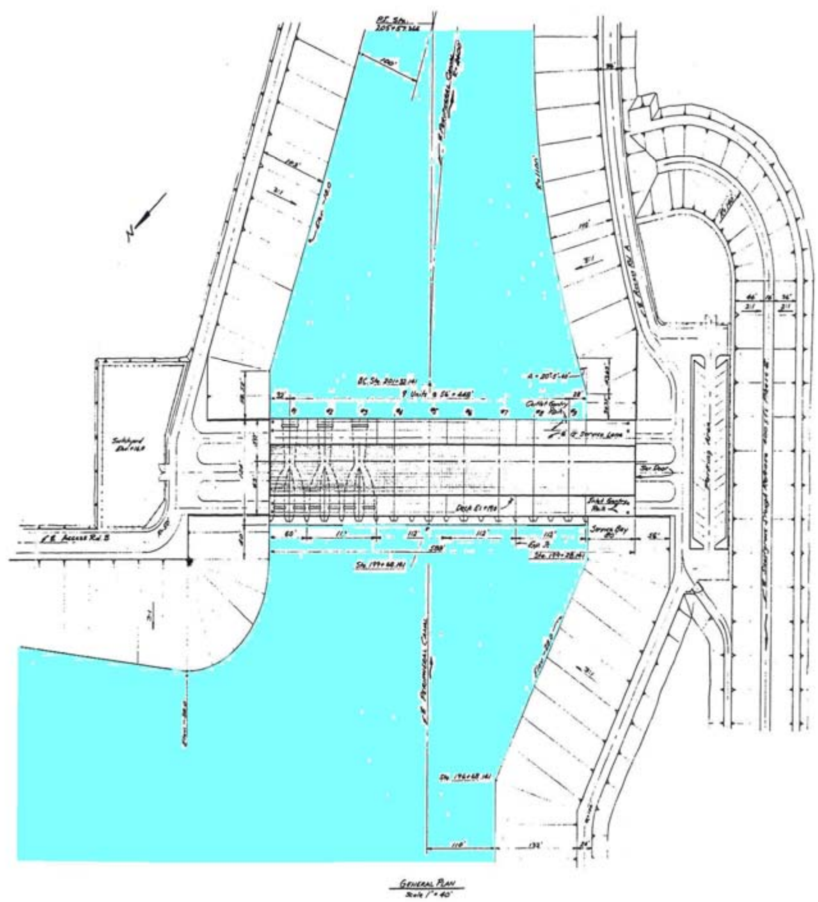


Figure 9: Pumping Plant Layout

3.6 Other Structures

3.6.1 Siphons

Three siphons (Stone Lake Drain, Lost Slough, and Mokelumne River) will be provided to isolate the TDF canal flow from the natural drainages. At these locations the TDF canal will be taken through the siphons. All siphons will be sized to keep the sediment from depositing. The siphon was designed for a minimum velocity of 5 ft/s. For a width of 90 feet the approximate depth of the siphon is 8 feet. Both upstream and downstream ends of the siphons will have trash boom, transition structures, and riprap protection (See, Figure 10).

The TDF canal embankment will be strengthened to prevent exchange of water between TDF canal and major drainage channels, particularly during high flows.

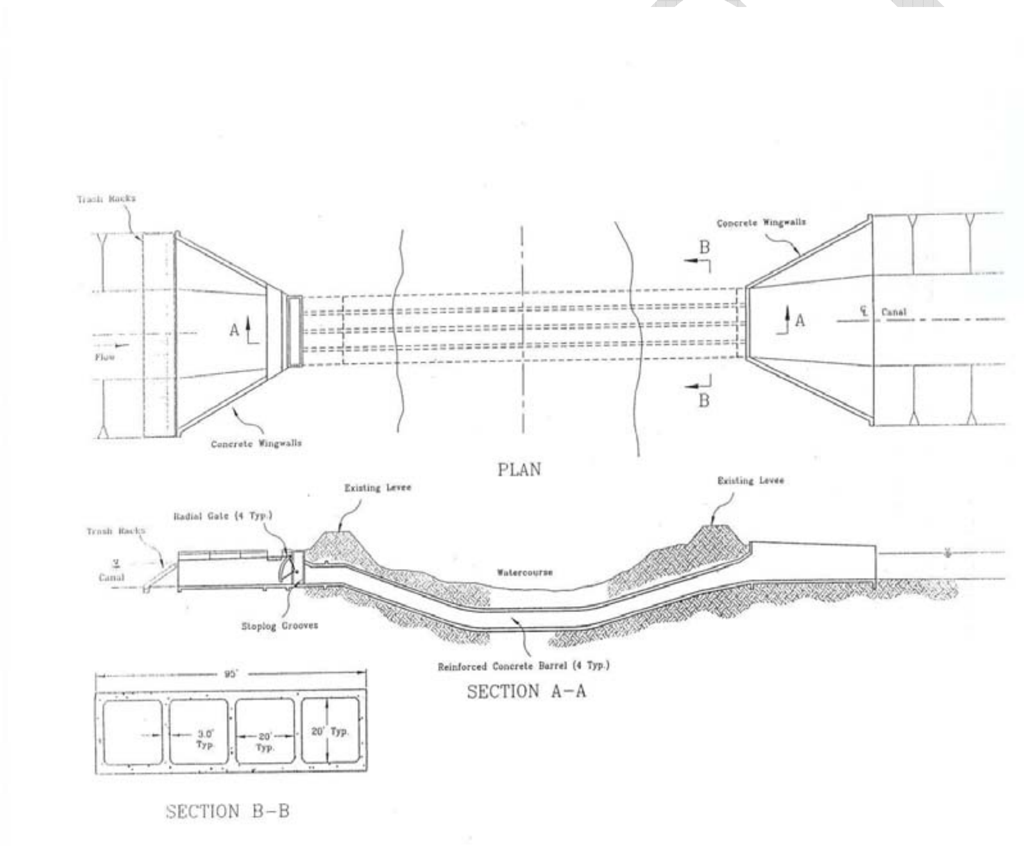


Figure 10: Siphon Structure

3.6.2 Bridges

A total of five bridges will be provided along the TDF alignment, Highway 160, Lambert Road, Twin Cities Road, and Walnut Grove-Thornton Road. The bridge on Highway 160 is a major bridge whereas the remaining are county road bridges. Locations of bridges and siphons along the alignment are given in Table 4. Typical bridge section is shown in Figure 11.

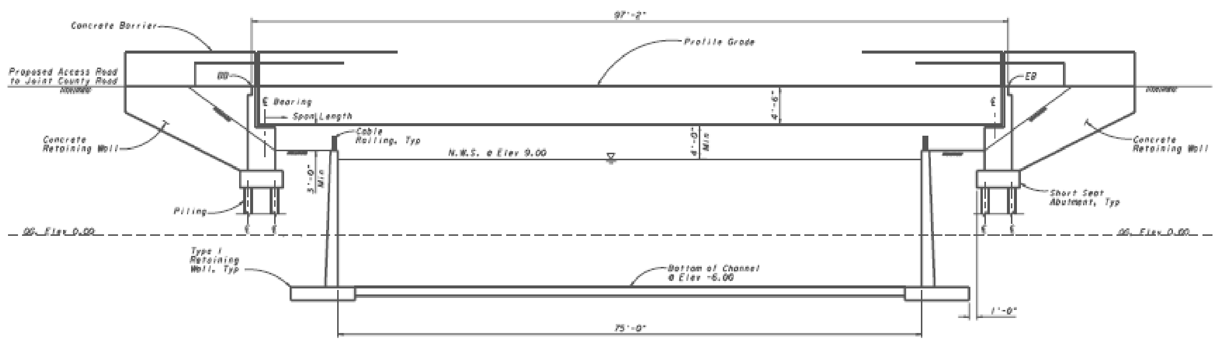


Figure 11: Typical Bridge Section

Table 4: Major Bridges and Siphons along the TDF alignment

Structure	**Approximate Location (mile)**	**Remark**
Highway 160 Bridge	0	Major Highway, 2 Lane Bridge
Lambert Bridge	3.3	County Road, 2 Lane Bridge
Stone Lake Drain Siphon	3.6	Siphon, approximately 500 ft long to divert Stone Lake Drain
Twin Cities Bridge	6.4	Major County Road, 2 or 4 Lane Bridge
Lost Slough Siphon	7.0	Siphon to drain Mokelumne River
Mokelumne Siphon	8.3	Siphon to drain Mokelumne River
Walnut Grove Road Bridge	10.3	Major County Road, 2 or 4 Lane Bridge
Outlet Structure	11.8	

3.6.3 Outlet Structure

The TDF outlet is located at the South Fork of Mokelumne River, near its confluence with Beaver Slough. The location of outlet structure was decided by the project need. The Outlet structure was designed to release the 4,000 cfs of flow. The main features of the outlet consist of a flood gate, bar rake, and a riprap floor to prevent scouring. The flood gates will be used to prevent the Mokelumne River flood entering into the TDF channel. The bar rake will be used as fish control gate to prevent the large fish from entering into the canal.

Passages to the migrating and local Delta fish species is critical with any projects located in Delta. If it is thought that the migrating fish are confused by the operation of the TDF, then fish control gates would be needed at the outlet facility. If the gates are provided at the outlet facility then fish collection and handling facility might also be required.

3.7 Canal Seepage

There will be some exchange of mass between adjacent field and canal, particularly at the beginning of the operation of the TDF. However, the ground water elevation of the area is close to the existing ground level, so the available head to drive the seepage water is not large. The seepage from the canal is expected to diminish with time because of the settlement of fine sediments in the canal.

3.8 Utilities Relocation

There is no major relocation of existing utilities along the TDF alignments. At this point there is no detailed information for the underground cables or gas pipelines requiring relocation.

3.9 Delta Channels

To transfer the water to the state and federal pumping plants, this plan uses new canal as well as the existing Delta Sloughs. However, the existing Delta Sloughs will be subjected to high flows for a sustained period. This could impact on channel erosion, sedimentation, and levee stability. In order to handle the increase flow in the Delta channels, the plan may possibly require enlargement of Beaver Slough, and South Fork Mokelumne River between Beaver Slough and Terminous. The plan will also require strengthening of several Delta Levees. Since the Delta levees are built on soft peat soil, they are vulnerable to failure and the overall reliability and integrity of the water transfer system is poor.

3.10 Operation and Maintenance Issues

The main operation and maintenance issues include embankment maintenance, pumps, trash racks and fish screens maintenance, seepage system monitoring, weed control, fisheries monitoring, Delta Levee maintenance, and bridge and siphons monitoring.

4. Project Cost

The preliminary estimated cost of the TDF project is 360 million dollars. This cost estimate excludes cost for cultural resources preservation associated with mitigation and recovery. The estimate also excludes estimates for relocations, land and right of ways, engineering design, supervision and administration, and project indirect cost (such as, project staff, job site facilities, utilities, and equipment). The construction cost estimate for each component is summarized in Table 4.

Table 4: Itemized Construction Cost for TDF

Item	Cost ($1000)
General (mobilization and demobilization)	8,736
Inlet Structure	43,948
Pump Station	58,814
TDF Canal	87,420
Siphons	13,790
Bridges	33,751
Outlet and Miscellaneous Structures	3,941
Subtotal	250,400
Contingency	100,160
Total	350,560
Rounded Total	360,000

5. Conclusions and Recommendations

The TDF project envisions diverting 4,000 cfs water from Sacramento River near Hood to South Fork of Mokelumne River near Beaver Slough. The project components include an intake facility, approximately 12 mile long unlined canal, three siphons, six bridges, and an outlet structure. The pertinent facilities in the intake include a trash boom, flood gate, trash rack, fish screen, bypass channel and a pumping plant.

The pre-feasibility level study concludes that based on the present evaluations the TDF project construction is possible with an acceptable engineering risk. The estimated capital cost of the project is $360 million.

At this pre-feasibility level the conclusions are based on limited hydrological, topographical, and physical data and are preliminary. Further steps in the design and engineering analyses should include detailed field surveys of the alignment, geological investigations, and right of way investigations.

Appendix A: TDF Fish Screen Facility Design Criteria

Fish Screen Facility Design Criteria and Recommendation for TDF

The objective of diversion fish screens is to effectively protect juvenile fish from entrainment, impingement, and migration delay. To this end, the National Marine Fisheries Services (NMFS) and California Department of Fish and Game (DFG) have established a number of criteria for the design and operation of fish screens installed at diversion points. The criteria are related to biological considerations, and hydraulic and hydrologic requirements for fish screening structures.

Approach velocity

1. For self cleaning screen, the approach velocity should be less than
   - 0.33 ft/s, for flowing water (DFG B1)
   - 0.2 ft/s, if Delta Smelts are present (DFG B1 Note 2)
2. The approach velocity is the water velocity 3 inches in front and perpendicular to the screen face. The exposure to the fish screen shall not exceed 1 minutes.
3. The approach velocity in front of the screen should be distributed uniformly across the face of the screen (NMFS B4).

Sweeping Velocity

4. For instream intakes the flow velocity component parallel to the screen face, known as sweeping velocity, must be twice the approach velocity (NMFS C1 DFG 3A).

Screening Opening

5. For vertical profile bar type fish screens, the screen openings should not exceed 0.0689 inches (DFG 4D; NFMS D1).
6. The screen material shall provide a minimum of 27 percent open area (NFMS D1; DFG 4A).

Other Recommendations

7. Where physically practical and biologically desirable, the screen face shall be placed generally parallel to the river flow and adjacent bank lines (DFG 1A; NMFS A1). The intake facility should be designed to minimize or eliminate areas of reverse flow or slack water. These areas are predator habitat.
8. The structure must allow migrants to move freely in the channel adjacent to the screen area. The transition between the fish screen structure wing walls and the channel embankment should be smooth.
9. For all hydrologic conditions, the screen material should be strong enough to take the water pressure caused by differential head over the screen faces. The fish screen material used should be corrosion resistant and antifouling (DFG 5B; NMFS D3).
10. The head difference to trigger fish screen cleaning shall be a maximum of 0.1 feet (NMFS J3).

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING

TITLE **Through Delta Facility**
LOCATION SOUTH DELTA WATER MANAGEMENT FACILITIES

ESTIMATES NO. **Prelim-1**
Bid Schedule

ESTIMATED BY: D.R. Williams
DATE **2/20/2007**
CHK. BY

Item No.	Item	Estimated Quantity	Unit	Unit Price $	Total $	Comment Working
	GENERAL					
1	Project Information; 6 each @ Bridge Xings	6	EA	6,000.00	36,000.00	From Barriers
2	Mobilization @ 1% of Total CP	1	LS	3,480,000.00	3,480,000.00	1% Final
3	Dewatering	1	LS	1,740,000.00	1,740,000.00	0.5% Final
4	Demobolization	1	LS	3,480,000.00	3,480,000.00	1% Final
	INLET STRUCTURE					
5	Clearing and Grubbing	21	ACRE	4,400.00	92,400.00	From Barriers
6	Top Soil-Stockpile	33,880	CY	25.00	847,000.00	From Barriers
7a	General Excavation	112,809	CY	20.00	2,256,180.00	From Barriers
7b	Sediment Basin Excavation	15,445	CY	30.00	463,350.00	
8	Compacted Embankment	124,825	CY	12.00	1,497,900.00	From Barriers
9	Imported Backfill	30,740	CY	55.00	1,690,700.00	From Barriers
10	Stone Slope Protection	17,700	TON	35.00	619,500.00	From Barriers
11	Drain Pipe	1,500	LF	4.00	6,000.00	From 99-27
12	Concrete	4,500	CY	155.00	697,500.00	Estimated
13	Splitter Wall Concrete	375	CY	160.00	60,000.00	Estimated
14	Steel Reinforcement	6,449,000	LB	1.50	9,673,500.00	From Barriers
15	Geotechnical Fabric	7,000	SY	3.50	24,500.00	From Barriers
16	Aggregate Base	1,970	CY	8.00	15,760.00	From Barriers
17	Drain Gravel	4,100	TON	50.00	205,000.00	From Barriers
18	Chain Link Fence, 8'	126,720	LF	37.00	4,688,640.00	From 99-27
19	Walk Gates	96	EA	200.00	19,200.00	From 99-27
20	Single Drive Gates	96	EA	600.00	57,600.00	From 99-27
21	Double Drive Gates, Motor Operated	48	EA	5,200.00	249,600.00	From 99-27
22	Radial Gates; 117' x 10'	2	EA	877,500.00	1,755,000.00	Crothers
23	Radial Gates; 111.25' x 10'	2	EA	834,375.00	1,668,750.00	Crothers
24	Trash Boom	288	LF	1,800.00	518,400.00	From Barriers
25	Fish Screen Structure	15,840	SF	440.00	6,969,600.00	Crothers
26	Fish Screen Cleaning System	1	LS	1,742,400.00	1,742,400.00	BEN
27	Fish Screen Outlet Pipe Manifold, 4' dia.	230	LF	500.00	115,000.00	Crothers
28	Fish Pump, 70 HP	1	EA	76,200.00	76,200.00	Crothers
29	Fish Outlet Channel Structure	964	LF	168.00	161,952.00	see backup
30	Fish Bypass Channel Structure	1,045	LF	214.50	224,152.50	see backup
31	Trashrack and Trashrake	120	LF	9,375.00	1,125,000.00	Spec 04-02
32	Issolation Jt, Bldg. Jt. Filler, Water Stops	1	LS	15,000.00	15,000.00	From Barriers
33	Miscellaneous Metal	50,000	LB	3.00	150,000.00	From Barriers
34	Railings (Metal Guardrails & Handrails)	5,800	LF	120.00	696,000.00	see backup
35	Metal Beam Guard Rail	1,200	LF	820.00	984,000.00	From Barriers
36	Transition Structure	1	LS	1,130,000.00	1,130,000.00	Estimated
37	Flow Meters	4	EA	50,000.00	200,000.00	From Barriers
38	Landscaping	1	LS	4,000.00	4,000.00	Ball Park
39	Mechanical	1	LS	1,000,000.00	1,000,000.00	Ball Park
40	Electrical	1	LS	2,000,000.00	2,000,000.00	Ball Park
41	Control Building	1	LS	248,000.00	248,000.00	From Barriers
	PUMP STATION					
42	Propeller Pumps, 36" casing, 14'Long, 833cfs/pump	5	EA	11,700,000.00	58,500,000.00	Estimated
43	Pump Station Housing	1	LS	59,120.00	59,120.00	Estimated
44	Railings (Metal Guardrails & Handrails)	500	LF	60.00	30,000.00	see backup
45	Concrete; Inlet invert and walls	900	CY	250.00	225,000.00	Estimated
	THRU DELTA CANAL					
46	Clearing and Grubbing	470	ACRE	4,400.00	2,068,000.00	From Barriers
47	Top Soil-Stockpile	758,267	CY	25.00	18,956,675.00	From Barriers
48	General Excavation	1,760,404	CY	9.00	15,843,636.00	Estimated
49	Compacted Embankment	1,638,674	CY	10.00	16,386,740.00	Estimated
50	Imported Backfill	230,350	CY	45.00	10,365,750.00	Estimated
51	Finish Grading	480	ACRE	1615.00	775,200.00	Estimated
52	Primary Access Road (Ag. Base)	2,980	LF	50.00	149,000.00	Estimated
53	Secondary Access Road (Chip Seal)	2,980	LF	25.00	74,500.00	Estimated
54	Boom Floats	424	LF	316.00	133,984.00	From Barriers
55	Buoys	50	EA	250.00	12,500.00	From Barriers
56	Signage	75	EA	3,000.00	225,000.00	From Barriers
57	Flow Meters	6	EA	50,000.00	300,000.00	From Barriers
58	Fencing R/W	885,000	LF	25.00	22,125,000.00	From 99-27
59	Landscaping	1	LS	4,000	4,000.00	Ball Park
	SIPHONS					
60	Snodgrass Slough Siphone (Lost Slough)	1	LS		5,098,370.00	Friesen
61	Stone Lake Siphone	1	LS		5,850,870.00	Friesen
62	Mokelumne River Siphone	1	LS		2,840,870.00	Friesen
	BRIDGES					
63	Hwy-160 Bridge	1	LS	8,520,682.50	8,520,682.50	DRW
64	Lambert Bridge	1	LS	6,832,622.76	6,832,622.76	YenHsi
65	Twin Cities Bridge	1	LS	6,129,264.53	6,129,264.53	YenHsi
66	Lauffer Bridge	1	LS	6,129,264.53	6,129,264.53	YenHsi
67	Walnut Grove Bridge	1	LS	6,129,264.53	6,129,264.53	YenHsi
68	Landscaping	2.48	ACRE	4,000	9,920.00	Rough
	OUTLET STRUCTURE					
	At Mokelumne River; North of Beaver Slough					
69	Grading	20	ACRE	1615.00	32,300.00	Estimated
70	Stone Slope Protection	3,000	TON	35.00	105,000.00	From Barriers
71	Flow Meters	6	EA	50,000	300,000.00	From Barriers
72	Water Diversion, Mokelumne River	1	LS	500,000	500,000.00	
73	Bank Protection, Mokelumne River	1	LS	1,000,000	1,000,000.00	
74	Dredging, Mokelumne River	1	LS	2,000,000	2,000,000.00	
75	Landscaping	1	AC	4,000	4,000.00	Ball Park
		SUBTOTAL =			$250,400,318.36	
		CONTINGENCY =		40.00%	$100,160,127.34	
		TOTAL =			$350,560,445.71	
		ROUNDED **CONTRACT ESTIMATE =**			**$360,000,000.00**	